NISAC

Infrastructure-Interdependency Management: Urban Population Mobility Simulation Technologies

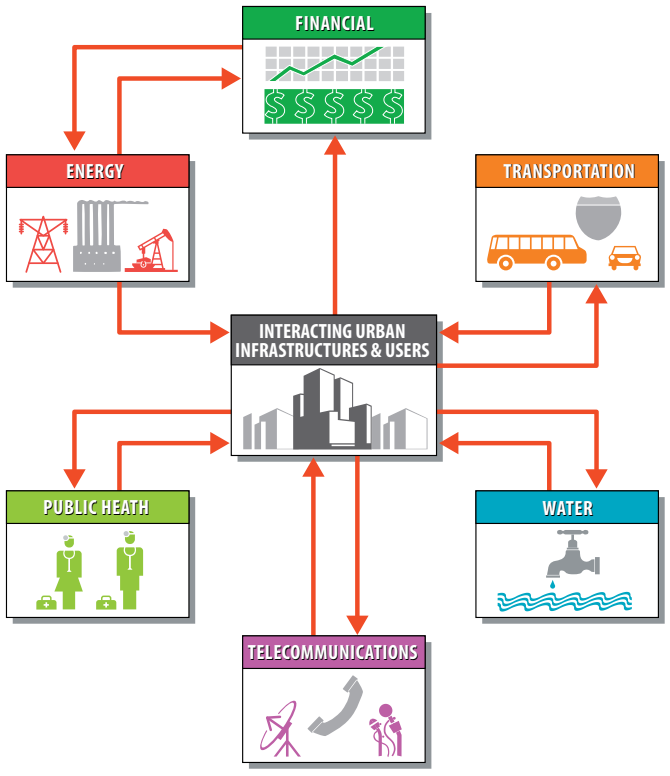
The National Infrastructure Simulation and Analysis Center (NISAC) provides advanced modeling and simulation capabilities for the analysis of critical infrastructures and their interdependencies, vulnerabilities, and complexities. These capabilities help improve the robustness of our nation's critical infrastructures by aiding decision makers in the areas of policy analysis, investment and mitigation planning, education and training, and near real-time assistance to crisis response organizations.

The Department of Homeland Security's (DHS) Information Analysis and Infrastructure Protection (IAIP) Directorate sponsors the NISAC program. NISAC is a core partnership of Sandia National Laboratories (SNL) and Los Alamos National Laboratory (LANL). NISAC integrates the two laboratories' existing expertise in modeling and simulation to address the nation's potential vulnerabilities and the consequences of disruption among our critical infrastructures.

The Urban Infrastructure Suite (UIS) is a set of seven interoperable modules that employ advanced modeling and simulation methodologies to represent urban infrastructures and populations. (See figure at right.) These simulation-based modules are linked to model urban transportation, telecommunications, public health, energy, financial (commodity markets), and water-distribution infrastructures and their interdependencies.

The Urban Population Mobility Simulation Technologies (UPMoST) Module provides a common interface for the flow of information between UIS sector simulations. UPMoST serves as the central link of the UIS that allows us to model and analyze the complex interdependencies among various urban infrastructures.

As illustrated in the figure below, all information describing the synthetic population and elements of the built urban environment generated by the Transportation Analysis Simulation System (TRANSIMS) flows through UPMoST to the other UIS modules. In addition, changes in the urban infrastructure arising during the course of a simulation that constrain activities and locations of the population pass between the modules through UPMoST, where sector-specific information is transformed into a common format.



The relationships between UPMoST (in center, dark grey) and the other UIS modules.

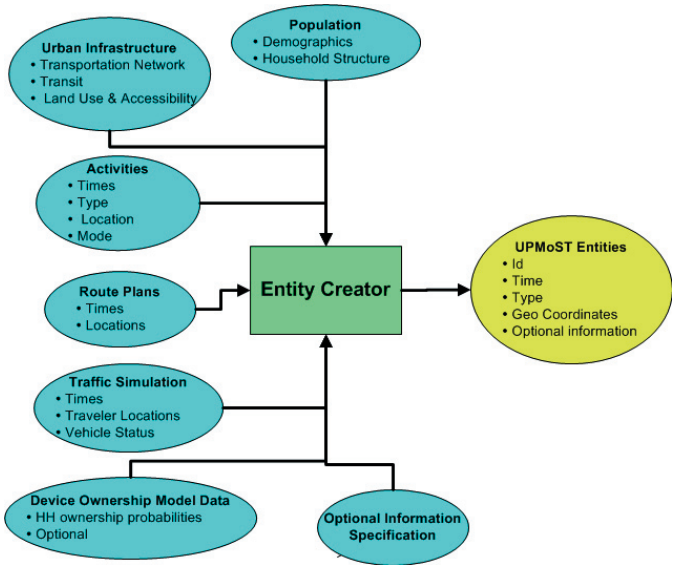
Key Features. UPMoST makes information available to the other UIS modules in the form of a consistent data structure called an UPMoST entity. An entity can represent a person, a vehicle, or an infrastructure element such as a hospital. Each entity is identified by a unique identification number.

Entity information is divided into two types: (1) static information that does not change over the course of a simulation, such as age, income, and home location, and (2) time-dependent information such as an individual's location, activity type, and health status.

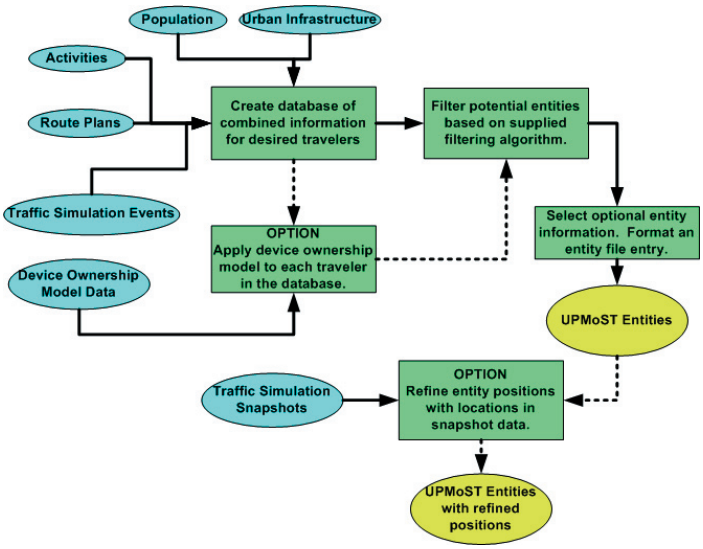
UPMoST contains an Entity Creator module that takes population-mobility data from TRANSIMS, filters and collates the data, and produces UPMoST entities, which are sent to the other UIS modules.

The upper figure at right shows the data flow into the Entity Creator module. The lower figure at right shows the process used by the Entity Creator module to create UPMoST entities.

UPMoST's ability to handle data sets larger than 10 gigabytes, for instance to simulate a metropolitan area, is due to the parallel-execution capability of the Entity Creator module. All of the UIS modules use a common architecture for data exchange that originates in UPMoST. Accessing the data usually requires an indexed-lookup capability that is supported by UPMoST. UPMoST entities encapsulate city-specific information in a generic data format; the generic methods used to generate UPMoST entities can be applied to any city.



The data flow into the Entity Creator module that produces UPMoST entities.



The process that the UPMoST Entity Creator uses to filter and collate data to produce UPMoST entities.

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